

punching or shearing rolled zinc plates is about 30 per cent. of the energy required to punch or shear mild steel plates. The ductility of rolled zinc is much less than that of mild steel, and the ductility of zinc plate with the grain is greater than the ductility across the grain.

In the new Liverpool Adelphi Hotel of the Midland Railway Company, which was opened a few days ago, uniform and accurate time is secured throughout by an installation of upwards of 200 electrical impulse dials on the "Synchronome" system, all operated by one controlling pendulum. It is necessary that electric clocks in bedrooms should be silent in action, and this condition is fulfilled by those on the "Synchronome" system.

PROF. KAMERLINGH ONNES directs our attention to an error in our note of March 14 (p. 41) on his measurements of the resistance of mercury at low temperatures. The values there given are not resistivities, but the resistances of a wire of solid mercury.

OUR ASTRONOMICAL COLUMN.

THE ECLIPSE OF APRIL 17.—Anyone intending to see the eclipse of the sun from a station on the central line as it crosses France will find several points of interest in M. Fayet's article in the *Revue Scientifique* for March 30.

After explaining eclipses in general, M. Fayet describes the conditions of the coming eclipse, and illustrates his description with several maps and diagrams; he also gives numerous tables of position angles, times, &c., for many stations in France. It would appear that a total eclipse is not likely to be seen in France, and in any case spectrographic and any long-exposure work are out of the question; but M. Fayet shows that from the point of view of geometrical astronomy the eclipse is a most important one, giving exceptional facilities for delicate determinations of the moon's place, the apparent size of the moon, and the figure of the earth. There are, then, plenty of possibilities of a large number of amateurs making observations of great value, even if the eclipse is only an annular one; no expensive instruments will be necessary, and the value of the observations will be greatly enhanced as they are multiplied in number. In France the observers are being officially organised, and preparations are being made for the distribution of the exact time and the coordination of the results. St. Germain-en-Laye, a few miles west of Paris, would appear to be one of the most readily accessible points near to the central line.

In the *Comptes rendus* (No. 14) for April 1 M. Bigourdan discusses very clearly, and explains in detail, the observations which may be made for the better determination of the moon's apparent diameter and position, and the reasons for making them during this particular eclipse.

THE EL NAKHLA EL BAHARIA METEORITE.—The meteoritic fragments which fell in Lower Egypt on June 28, 1911, are described in detail by Dr. John Ball in Survey Department Paper No. 25. Altogether some forty stones, weighing nearly 10 kgms., have been collected, but, as the explosions producing the fragments are supposed to have taken place at a considerable altitude, scattering the pieces over an area about 4½ kms. in diameter, this probably does not represent the total mass as it entered the earth's atmosphere. The weight of the heaviest fragment is

1,813 grams, and of the smallest about 20 grams; some small fragments have a fused skin all over their surfaces while others are only partially covered, thus indicating a succession of explosions. A portion of the stone was submitted to Sir Norman Lockyer for spectroscopic analysis, and his report places the spectroscopic prominence of the various elements in the order Cr, Na, Ca, Al, Mg, Si, Mn, Fe, V, Ti, and K; the last is very weak. A chemical analysis by Mr. W. B. Pollard gives SiO₂, 50; FeO, 20; CaO, 15; MgO, 12; and Al₂O₃, 1·65 per cent.; Cr₂O₃ appears as 0·23 per cent., and traces of the other elements were found. Although this is the first "find" in Egypt, Dr. Ball believes that a large meteorite fell in a direction 32° W. of true N. from Philæ on April 5, 1902; such phenomena as attend these falls were then observed, but no stone was found.

A DAYLIGHT METEOR.—The director of the Meteorological Office informs us that at Brocklesby, Lincs, on March 28, Mr. F. J. Gibbons observed a vivid meteor at 2.50 p.m. in broad daylight on a bright afternoon. The meteor appeared to move from south to east in a downward course. It would be interesting to know if the meteor was observed elsewhere. Observations of meteors in daylight appear to be uncommon, although particulars of a certain number are given in the annual reports of the British Association Committee on luminous meteors.

THE STONYHURST OBSERVATORY.—Father Sidgreaves's report of the meteorological and magnetical observations made at Stonyhurst during 1911 contains the usual tabular summaries with a few notes on the more important points. The observations of sun-spots and of magnetic declination point to 1911 being a minimum epoch for each, but later observations must be awaited to fix this point with certainty.

PHOTOGRAPHS OF HALLEY'S COMET.—The first fascicule of vol. v. of the *Annales de l'Observatoire astronomique de Tokyo* is devoted to Halley's comet as observed at Dairen, Manchuria, during the months April-June, 1910, by MM. Sotome and Hoasi; photographs taken at Tokyo by M. Toda are also included. The form, changes, and length of the tail and the acceleration of its particles are discussed at length, and there are nineteen plates of excellent reproductions of photographs, 131 in all, at the end of the work.

CYCLES OF THE SUN AND WEATHER.

SINCE Sir William Herschel suggested that variations in the visible changes of the sun's surface might be sensibly reflected in the meteorology of our planet, many investigators of high authority have endeavoured to determine the precise nature of the relationship between solar and terrestrial phenomena. In the seventies of last century it was decisively shown that the variation of certain meteorological elements coincided with that of photospheric activity as revealed by observations of sun-spots. The conclusions arrived at were expressed very definitely by Prof. A. Schuster in a paper presented to the meeting of the British Association in 1884. "There can," he said, "be no longer any doubt that during about four sun-spot periods (1810 to 1860) a most remarkable similarity existed between the curves representing sun-spot frequency and the curves of nearly every meteorological element which is related to temperature. This is not, in my opinion, a matter open to discussion: it is a fact."

But though a connection was established, further studies of its character seemed to lead to contradictory conclusions. High air temperatures were

associated with lowest sun-spot conditions, while the frequency of tropical cyclones and abundance of rainfall, which should *prima facie* show the same relationship, suggested that there was increased movement and evaporation about the maximum epoch of the sun-spot period. As the results obtained from the different groups of facts could not be reconciled, the discussion of the subject was for some years in abeyance. Broader views are, however, now being taken; and it is realised that many sun-spots may mean increased rainfall in one part of the world and decreased in another, or the like inversion of any other meteorological element. Also, the development of means of obtaining more complete records of changes upon the sun's surface, in addition to those manifested by sun-spots, has encouraged further inquiry into the subject of solar influence.

Full knowledge can only be secured when the new methods have been used for many years, but, so far as the discussion has proceeded, it indicates that there is no real inconsistency in the earlier conclusions, and that studies of the sun offer the most promising prospects of success in long-range weather prediction. Meteorological analysis of observations made at a solar physics observatory has become even more important than consideration of the results from an astronomical point of view. As was remarked in a report of the U.S. Weather Bureau a few years ago:—"Advances in the period and accuracy of weather forecasts depend upon the exact study and understanding of atmospheric pressure over large areas, and a determination of the influences, probably solar, that are responsible for ordinary and extraordinary distributions of atmospheric pressure upon the earth's surface."

We may take it for granted that the weather of any region is determined mainly by the barometric pressure and the interchange of areas of high and low barometer. The most important variations to consider are, therefore, those of atmospheric pressure, and the conclusions arrived at may then be used for comparison with variations of solar phenomena independently determined. The unit of inquiry should, however, be the world, and not one particular region; and there should be no assumption, as was formerly common, that solar changes indicated by sun-spots or other phenomena would affect the whole of our globe simultaneously and in the same direction at any particular epoch. Investigations carried on in recent years in this spirit have led to results which are both stimulating and valuable. For convenience we will refer first to the meteorological conclusions, then to solar changes, and finally to the relationships found between sun and earth.

Periodic plus and minus "pulses" of rainfall in India were described by Sir Norman and Dr. W. J. S. Lockyer in a paper read before the Royal Society in November, 1900, and were shown to be related (sometimes inversely) to similar variations at Mauritius, Cordoba (South America), the Cape of Good Hope, and other places. Attention was then devoted to an examination of the variations of pressure over the Indian and other areas, and a period of about 3.5 years (always referred to later as the 3.8-year periodicity) was found in the mean variation of pressure over the whole of India and at individual stations, and also in other large areas. An inverse variation was found in the pressures at Cordoba, and, referring to it, the authors remarked:—"The cause, therefore, which raises the mean value for the low-pressure months over the Indian area would appear to lower the mean value of high-pressure months at Cordoba simultaneously. In fact, we have a see-saw" (Proc. Roy. Soc., lxx., June 19, 1902). The area affected by this barometric see-saw was extended in a later paper

(Proc. Roy. Soc., lxxi., December 4, 1902) to Ceylon, Java, Mauritius, and Australia, and further results were described in 1904.

H. F. Blanford and Hildebrandsson had previously found similar evidence of reciprocal barometric variations in widely separated regions, but the extension of the investigation to about a hundred stations in various parts of the earth led to the important result that there exists a world-wide barometric see-saw between two nearly antipodal parts of the earth, one region about India and its neighbourhood showing exactly opposite effects as regards atmospheric pressure in any year to those felt in a region which includes South America and the southern parts of the United States.

The pressure variations in the British Isles year by year do not go up or down with either side of this see-saw, but appear to be a mixture of both types. During some years the British area is enveloped in the pressure system that extends over the large region of which India is about the centre, while for another series it is dominated by the conditions of atmospheric pressure experienced in the region of which South America is the middle portion. On this account the cycle of 3.8 years distinctly exhibited in the meteorological records of two great regions of the world appears in British meteorology at a period of about three years, in the course of which variations are sometimes very noticeable. An examination of the records of annual rainfall at Greenwich for sixty years shows this three-year cycle very clearly. Taking a series of years, it is found that two wet years are followed by a dry year; but after eight years a reversal takes place, two dry years being followed by a wet one. This peculiar result is due to the combination, in the British Isles, of the Indian and South American pressure systems, which have a definite period of change—one going up while the other goes down—in a period of about 3.8 years.

Passing now to solar conditions, we have, first of all, the well-known sun-spot period of about eleven years. This is the mean length of the period; and it must be remembered that epochs of maximum activity, as indicated by frequency and magnitude of sun-spots, do not follow those of minimum activity at constant intervals, but vary from about three to five years. Moreover, when a critical examination is made of solar phenomena, it is found that successive cycles differ from one another in certain respects. Dr. Lockyer discovered that underlying the ordinary sun-spot period there is another of greater length, namely, about thirty-five years. In other words, the sun has to pass through about three cycles of activity before it reaches the same state as it was before. Sun-spots must not, of course, be taken as the sole criteria of the sun's condition; and it was pointed out by the Lockyers in 1900 that "there seems little doubt that in the future the measure of the change in the amount of solar energy will be determined by the amount and locus of the prominence area" (Proc. Roy. Soc., lxxvii.). The solar latitudes in which sun-spots most frequently appear vary with the epoch of the sun-spot period, and the eruptive prominences have their maxima in the same latitude as the spots. A detailed examination of the records connected with solar spots and prominences revealed subsidiary maxima and minima of about 3.8 years (*ibid.*, lxx., 503), so that three waves of solar activity have to be considered having approximate periods of four, eleven, and thirty-five years. The condition of the sun at any time represents the algebraic sum of these coefficients of activity.

The correlation of the factors of terrestrial weather now becomes possible. In the first place, the old view that the sun's influence upon weather must be general

has been abandoned—as it should have been long ago. As the earth's atmosphere is a constant quantity, the crest of a wave in one part must be compensated by a trough in another. Solar action must thus have a double effect of opposite nature upon the atmosphere. High pressure in one region must be counter-balanced by low pressure elsewhere, and maximum rainfall in one region will coincide with minimum rainfall in another part of the globe. This is the explanation of the apparent inconsistent conclusions arrived at in earlier investigations of relationships between solar and terrestrial weather. There is now no room for doubt that the earth's meteorological conditions vibrate in sympathetic response to solar periods of about four, eleven, and thirty-five years. There may be other periods of oscillation, but in any case these three exist upon the sun and earth, and can be traced in the records of many phenomena. The shortest wave has been established by the Lockyers for solar and terrestrial variations, and the longest, represented by Brückner's cycle on the earth, was discovered by Dr. Lockyer to have its counterpart on the sun.

It is not surprising that other investigators have arrived at much the same conclusions independently. In a paper published in *The American Journal of Science* of December, 1894, on "Inversion of Temperature in the 26.8-day Solar Magnetic Period," Prof. F. H. Bigelow showed that the northern low-pressure and the southern high-pressure belts of North America vary in latitude directly with what he described as "solar magnetic intensity." He referred in the paper to a period of about three years, but his curves (reproduced in *The U.S. Monthly Weather Review* of November, 1903) only relate to meteorology and magnetism, and not to solar activity, the connection between magnetism and prominences not being described by him, so far as we know, until 1902. In the following year Prof. Bigelow published a paper on "Synchronism of the Variations of Solar Prominences with the Terrestrial Barometric Pressures and the Temperatures," and showed direct and indirect changes of both pressure and temperature. In an article in *NATURE* of January 8, 1903, Dr. Lockyer gave full credit to Prof. Bigelow, and stated that the two investigations were in agreement as regards three main points, namely:—(1) close connection between solar activity and barometric pressure; (2) great extent of areas over which very similar pressure variations exist; (3) presence of two large areas over which the pressure variations are reciprocal to each other.

Quite recently a paper has reached this country (Bulletin No. 1 of the Argentine Meteorological Office) in which Prof. Bigelow deals with "The Synchronism between the Variations of Solar Phenomena and the Meteorological Elements in Argentina and the United States." It is not clear whether the Bulletin is intended to be a semi-popular statement of the position of the subject or a contribution to scientific literature, but the almost complete absence of reference to the work of others suggests the former conclusion. Anyone not familiar with the points of progress would be led to believe that Prof. Bigelow is personally responsible for practically all that is known of solar and terrestrial relationships. *L'État, c'est moi*, said Louis XIV. on one occasion, and this spirit prevails in the paper before us. The only reference to South Kensington relates to photographs with a spectroheliograph, and no mention whatever is made of the investigations of solar and terrestrial meteorology, which, as may be judged from the foregoing account, form a substantial part of the work of the Solar Physics Observatory.

R. A. GREGORY.

THE ETNEAN ERUPTION OF SEPTEMBER, 1911.

PROF. A. RICCO, director of the Observatory of Catania, has issued a preliminary report on the eruption of Etna which took place last September (*Boll. Sismol. Soc. Ital.*, vol. xv., pp. 273-280). The eruption may be said to have begun on the preceding May 27, when a new vent appeared on the north-east flank of the central crater less than a hundred metres below the rim, from which there issued hot white smoke, but no solid matter. In August, rumblings were heard in the central crater and in the new vent, and, from both, smoke and lapilli were discharged. This continued until the night of September 9-10, when a series of very strong earthquakes occurred, and a great radial fracture, eight kilometres in length, was formed, running in a N.N.E. direction from the new vent. Some of the earthquakes were felt as far as Mineo, 60 km. from the volcano. In the Observatory of Catania, 30 km. distant, the Vicentini microseismograph was almost continuously agitated from midnight to 6 a.m. on September 10. The strongest shock occurred at 2.14 a.m., and at the same moment a new vent was opened, about 4 km. from the central crater, from which smoke, ashes, lapilli, and stones were ejected. Later in the day, three new vents were opened, and by the next day there were sixteen in action, of which two emitted lava.

On September 12, the number of new vents was greatly increased. They seem to have followed the line of the great fracture. The highest group consisted of six vents in a N.N.E. line, from which a great quantity of fragmentary material had been ejected, but which on September 12 had become almost inactive. A little lower down, in the same direction, was a row of four vents; and, still farther, a line of six others, very active, which discharged incessantly great masses of smoke and large stones. Lower still was a fourth group, of four vents, arranged in a line bending towards the N.E., of which the two lower emitted small streams of lava. Continuing in the same direction is a tract of land to the south-east of Monte Nero, much fissured, and containing a long string of about thirty vents, from the lowest and largest of which issued an important stream of lava. To the north-east of Monte Nero, there started another line of craters (the sixth), about a score in number, from the lowest of which issued a second and larger stream of lava. This stream followed the course taken by the lava in 1646, and, travelling with great rapidity, crossed the Circumetnean railway on the evening of September 12. Between the two craters emitting lava was a seventh group of cones, throwing out incandescent matter.

On September 15 and 16, great masses of smoke were still emitted from the central crater and the vent of May 27. The two upper groups of vents were almost spent, the third continued very active; the fifth group of thirty or more vents emitted dense smoke and incandescent materials; in four days they had piled up cones some tens of metres in height; from the lowest lava still issued. The sixth group was also surrounded by lofty cones, from the lowest of which lava continued to flow at the rate of three metres a second.

The eruption ended tranquilly on September 23.¹ On October 1 the vents were again examined, and several changes were noticed. Those of the third group were united in four large craters; the fourth group consisted of twenty-seven vents, the fifth of

¹ The date is given as the 13th inst., but this is clearly a printer's error. On October 1 the eruption had been ended about a week.